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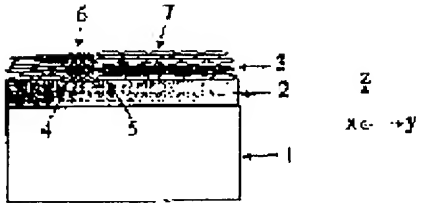
(54) LIQUID CRYSTAL CELL FOR OPTICAL PARTS

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an optical element which is arbitrarily changed in orientation in microscopic regions.
SOLUTION: The optical element has a cell consisting of a substrate 1 or two substrates parted from each other, one or more oriented layers 2 on the substrates and one or more anisotropic layers 3 of crosslinked liquid crystal monomers or oligomers. The surfaces of the oriented layers 2 adjacent to a liquid crystal layer 3 have oriented patterns 4, 5 having locally determined parallel or sectorial line structures. The average spacing between the lines is not larger than the thickness of the liquid crystal layer 3 and the angle between the adjacent layers is not larger than 3° .



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7. Registration info
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   * Date of extinction of right
8. Renewal date of legal status

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention is provided with one or two substrates, one or two orientation layers on each substrate, and the anisotropy film beyond one or it of a liquid crystal monomer or oligomer that constructed the bridge, and relates to the optical element from which the orientation of the liquid crystal element between the substrates on a substrate differs selectively. This invention relates to production and use of such an element again.
[0002]
[Description of the Prior Art]Adjusting an optical axis a priori by a high resolution, the transparence of anisotropy or the polymer network structure layer in color which carried out three-dimensional orientation is dramatically important in display technique, integrated light study art, and the field of forgery prevention. EP-A (European Patent public presentation) 545234 indicates a liquid crystal cell provided with the field of a refractive index which is different as a result in decided different orientation. The needle which moves according to the scanning pen of a scanned type microscope (a scanned type probe microscope or an atomic force microscope [AFM]) is used for this kind of a liquid crystal of refractive-index pattern, and it is produced by generating line structure in precision instrument on the surface of the orientation layer used as the boundary of a liquid crystal. A line can be made into the sequence of a comparatively clear slot or the molecule which only aligned uniformly with the power applied to a needle. Hereafter, the word "scratch (it scratches)" is used for the process of producing line structure by the means of a needle. The pattern of an orientation layer constitutes the orientation pattern transferred to a liquid crystal from a cell of the plate constituted in this way. It has the shape of a nonlinear liquid crystal optically, or the optical waveguide structure which fixed structure further is an important use.
[0003]EP-A611981 indicates the material and the method of stabilizing monomer liquid Akira's oriented structure according to bridge construction. The oriented structure of a liquid crystal is derived by the orientation layer of the polymer network structure ("PPN layer") in which a photo alignment is possible. For this purpose, a desired pattern is photochemically made from the 1st step by the PPN orientation layer by polarization, and it is moved to the liquid crystal layer formed on it of spin coating at the 2nd step (the PPN method). Next, a liquid crystal structure is stabilized by bridge construction. The liquid crystal layer over which this kind constructed the bridge calls it LPC (liquid crystal polymer) simply. Although the European Patent application No. 689084 describes the optic which has a layer system of many PPN orientation layers and the anisotropy layer of a bridge construction liquid crystal monomer, That is [it receives restriction of the PPN method altogether], resolution is restricted, and the director (director) cannot change the direction of a few, but inclines. (tilt tilt) Control of an angle is restricted.
[0004]the Switzerland patent application 2036th which has not been published yet -- /95 item describes the product which uses an optic as a mask, namely, transmits a polarization pattern to a polarization photosensitive layer, and its use. Especially the European Patent application No. 689065 describes the optical PPN element and production of a layer system suitable for forgery prevention.
[0005]
[Problem(s) to be Solved by the Invention]The purpose of this invention is to provide the optical element which changed orientation arbitrarily in the microscopic field.
[0006]
[Means for Solving the Problem]It turned out that it becomes the structure of having the completely new

characteristic with a more sufficient or liquid crystal which has the orientation layer which carried out the scratch in precision instrument and for which a bridge can be constructed. According to this invention, the surface of an orientation layer where the above-mentioned element adjoins a liquid crystal layer has an orientation pattern of a parallel or flabellate line structure where a part was decided, and an angle between adjoining lines is not larger than 3 degrees more greatly [an average interval between lines] than thickness of a liquid crystal layer. For example, it can do in this way and a smaller structure can also be produced as compared with the PPN method. In addition to a suitable direction, a tilt angle of a molecule can also be controlled and changed, and a suitable direction can also be changed continuously locally. As compared with a liquid crystal cell described by EP-A545234, an element of this invention accepts and is easy to come out of one substrate. The three-dimensional structure (composite layer) can also be constituted.

[0007]

[Embodiment of the Invention]Hereafter, an embodiment of the invention is described with reference to drawings. As shown in drawing 1, the orientation layer 2 is arranged on the substrate 1 (for example, glass). As for an orientation layer, it is preferred that it is made of polyimide, and it is preferred to be formed in a person skilled in the art by spin coating by a publicly known method. Rubbing (it rubs) is carried out to the y direction which shows an orientation layer in a figure at the 1st step by the usual method. The purpose is to make the direction of rubbing, and orientation of the almost same direction the liquid crystal layer which adjoins so that it may be publicly known. Next, the scratch of the desired orientation pattern is carried out with the needle like a precision instrument. The method of controlling a needle is publicly known by a scanned type probe microscope. A needle moves in parallel with a x axis, and produces a detailed structure which shows an outline in a figure on the surface in the slot 4. Next, a liquid crystal monomer mixture with desired preferred thickness is formed of spin coating. In the field 5 in which the liquid crystal layer 3 does not carry out a scratch, orientation is carried out to the direction of the original rubbing y at parallel, and orientation is carried out in parallel with the scratched direction x in the field 4 which carried out the scratch. An orientation pattern can be drawn in parallel with one needle or several needles.

[0008]Next, a liquid crystal layer is stabilized by chemical or photochemical bridge construction. If there is no necessity of solidifying each portion of a layer in photochemical bridge construction, an exposure can also be performed through suitable MASUKU ** at the above-mentioned step. So, the completed LCP layer is provided with the field 7 in which the liquid crystal element carried out orientation in parallel with the y direction of rubbing, and the field 6 which carried out orientation in parallel with the x direction of rubbing in this example. A needle can be used for controlling and adjusting the tilt angle of a liquid crystal element. A liquid crystal element does not need to be parallel to the surface, and only the angle decided by polymer of an orientation layer leans from the flat surface so that it may be publicly known. It is decided by the direction of rubbing or a scratch whether a positive angle degree will incline to a x direction, or a negative angle degree will incline. It is shown in drawing 5 how this is used by this invention. a) When raising a needle when returning, or b Returning, whenever it passes along the locus drawn before, the movement of a scratch can start in the same direction. Therefore, the delivery of a y direction must make it synchronize in the case of the latter. According to these two scratch methods, it becomes a tilt angle peculiar to the greatest polymer. In the scratch pattern shown in c), it becomes the tilt angle 0 and becomes a value smaller than the possible maximum tilt angle by the patterns d and e. So, a tilt angle can be controlled and adjusted by choosing the method of a scratch.

[0009]Since the polymer which constructed the bridge is mechanically stable, even if there is no ** with a buffer polymer layer, repeated use of the above-mentioned method can be carried out. This shows drawing 2. The layers 21, 22, and 23 are equivalent to the layers 1, 2, and 3 of drawing 1. After a bridge is constructed over the layer 23, rubbing is carried out again and a scratch is carried out in precision instrument. Or another layer can be formed before rubbing and a scratch, for example, can also improve an optical property or the orientation characteristic. Another orientation patterns 25 and 26 are made according to the spin coating of the layer 24, and subsequent bridge construction. If this method can be repeated as it is required, and constituted in this way, a three-dimensional refractive-index pattern will be obtained also in the direction of z. This invention is applicable to the place which needs the refractive-index pattern of the high resolution which static namely, is not switched anywhere. All the ranges that can use the element produced in the PPN process are included in the range of application. However, this invention can be used also in order to acquire an again more detailed structure, it can change the direction of a director continuously, can control a tilt angle further, and, in addition to the use of publicly known PPN, can also open a completely new possibility.

[0010]The optical waveguide of integrated light study, such as a coupler, geometry (for example, grating), a delay

line, and polarization influence structure are included in such a possibility. **** NLO which is activity -- if it combines with an activity element -- such optical waveguide structures -- it can be used for combining network structure by a simple method. Especially the three-dimensional network structure can use it for combining between the layers of an optical waveguide or passing without interference. One example of the possibility of this invention is 180-degree bending of the optical waveguide of drawing 3. If the light 31 is transmitted in the waveguide 33 and goes to the point 32, it will turn at 180 degrees. In order to produce this kind of waveguide structure, it is both the field 34 inside a bend, and the field 35 of the outside of a bend, namely, the direction of a scratch must be locally changed continuously in waveguide 33 the very thing. This cannot be performed even by the method of a publicly known throat.

[0011]A static refractive-index pattern can also be used for the mask of the high resolution for PPN illuminations again, for example. This inventions are Switzerland patent application the 2036/95. It can be used for producing the mask more complicated than the photolithographic method described by the item at a high resolution.

[0012]The static refractive-index pattern is dramatically important for the forgery prevention of an identification place and all the documents again. Since the scratch pattern of this invention is a high resolution, a refraction effect can be independently used as an element of protection. That is, a refractive-index pattern acts as a hologram by polarization. If the three-dimensional structure (volume hologram) is made as mentioned above, the efficiency of optical dispersion will be improved greatly. Combination with the PPN method is dramatically important for this invention again. A large field can be optically constituted by the PPN method, and a microstructure can be formed by the method of this invention after that. In that case, for example, the orientation layer 22 shown in the orientation layer 2 shown in drawing 1 or drawing 2 is not the polymer layer that carried out rubbing but not the polymer layer in which the interlayers 23 and 24 did the scratch but the polymer network structure where it formed with light and the scratch of another pattern was carried out after bridge construction. The same thing is applied to all the examples mentioned above.

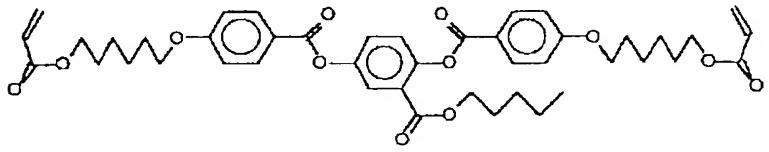
[0013]

[Example]The following diacrylate element was used as a monomer which can construct a bridge.

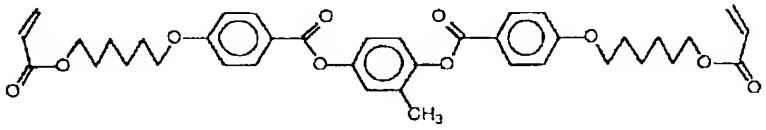
[0014]

[Formula 1]

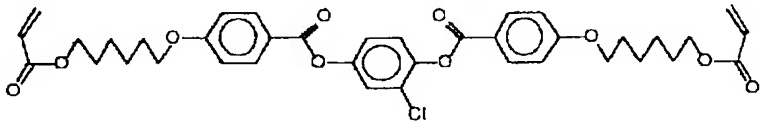
モノマー1



モノマー2



モノマー3



[0015]These elements are used for developing the nematic mixture MLCP which has the low melting point (about 35degreeC) especially and which can be supercooled, and can be prepared now at a room temperature. The ratio of the monomers 1, 2, and 3 in a mixture was 80:15:5. Photoreaction initiator IRGACURE 369 of ****- Guy Gee was added 2% into the mixture. The polyimide layer about 100 nm thick was formed in the specimen of the glass which coated ITO (indium oxide, tin) by publicly known spin coating. Rubbing of the layer was carried out by the usual rubbing device. Next, the scratch was carried out with the needle which has a variable diffraction constant and 45-degree diffraction grating structure drives by piezoelectricity to the original rubbing direction. This is shown in drawing 4 in graph. The sample 41 with which the table (v=3.6 mm/s) which moves in the direction of 45 was coated is fixed mechanically. It is fixed to the small stick 44 and the needle 43 is movable to the both directions of 46 and 47 by piezoelectricity. Corresponding to average interval 7.5 nm between the lines by which

the scratch was carried out, the fixed frequency of 240 Hz is applied in the direction 46, and the length of a line is 10 micrometers. The cycle which attaches a lattice is produced by periodic discontinuation of abnormal conditions. A needle can be made to go up and down in the direction of 47 periodically.
[0016]Next, an LPC layer is formed of spin coating (being [Parameter :] 2000 rpm for 2 minutes). By choosing the concentration of MLCP in an anisole solvent, layer thickness can be changed within large limits. In 5% of concentration, it becomes about 65-nm thickness, for example. Next, optical bridge construction of the layer was carried out with irradiation equipment (mercury arc light 30 minutes). The structure which constructed the bridge was inspected with the polarization microscope and the atomic force microscope (AFM). in the polarization microscope, the lattice could be clearly seen to the cycle of the lattice of 720 nm namely, -- in the limit of the resolution of a microscope, and, unlike other portions of a specimen, the portion 42 of drawing 4 had the double reflex which carried out orientation in the different direction. The cycle of the lattice was 240 nm when observed by AFM. These measurement showed that a very detailed refractive-index pattern could be produced in anisotropy crosslinked polymer.

[Translation done.]

* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1]A substrate.
One or an orientation layer beyond it.
Orientation which has the anisotropy layer beyond one or it of a liquid crystal monomer or oligomer which constructed the bridge and where liquid crystal elements differ locally.
It is the optical element provided with the above, and the surface of said orientation layer which adjoins said liquid crystal layer has an orientation pattern with a parallel or flabellate line structure where a part was decided, and, as for an average interval between lines, an angle between adjoining lines is characterized by not being larger than 3 degrees more greatly than thickness of said liquid crystal layer.

[Claim 2]A cell which consists of a substrate which set two intervals.
An orientation layer beyond one or it on each substrate.
Orientation which is arranged between said orientation layers and has the anisotropy layer beyond one or it of a liquid crystal monomer or oligomer which constructed the bridge and where liquid crystal elements differ locally.
It is the optical element provided with the above, and the surface of said orientation layer which adjoins said liquid crystal layer has an orientation pattern with a clearly parallel or flabellate line structure of a part, and, as for an average interval between lines, an angle between adjoining lines is characterized by not being larger than 3 degrees more greatly than thickness of said liquid crystal layer.

[Claim 3]An optical element which is an optical element indicated in claim 1 or any 1 paragraph of 2, and is characterized by said orientation layer consisting of polymer network structure formed of light.
[Claim 4]An optical element which is an optical element indicated in claim 1 or any 1 paragraph of 2, and is characterized by said line structure consisting of a grooved structural element formed in mechanization study.
[Claim 5]Are the optical element indicated in claim 1 or any 1 paragraph of 2, and at least one layer of a liquid crystal element which constructed the bridge, they are a monomer of a liquid crystal, or a mixture of oligomer -- at least -- during a period of a process -- an optical element characterized by having been a temperature gap of 1 degreeC and being a liquid crystal-like before bridge construction in the range of 0degreeC to 60 degreeC.
[Claim 6]A method which is a manufacturing method of an optical element indicated in any 1 paragraph of claims 1 thru/or 5, and is characterized by making the fine structure in precision instrument, then forming a layer of a liquid crystal oligomer or a monomer, and then constructing a bridge in a liquid crystal layer on the surface of an orientation layer.
[Claim 7]A method which is a manufacturing method of an optical element indicated to claim 6, and is characterized by changing with the directions of a line in which the direction of an optical axis carried out the scratch.
[Claim 8]A method which is a manufacturing method of an optical element indicated to claim 7, and is characterized by removing it after one of the two substrates constructs a bridge in a cell.
[Claim 9]At least one layer of a liquid crystal element which is a manufacturing method of an optical element indicated to claim 5, and constructed the bridge, they are a monomer of a liquid crystal, or a mixture of oligomer -- at least -- during a period of a process -- a method characterized by having been a temperature gap of 1 degreeC and being a liquid crystal-like before bridge construction in the range of 0degreeC to 60 degreeC.
[Claim 10]A device which uses an optical element indicated in any 1 paragraph of claims 1 thru/or 5 as an optical polarization pattern which was able to be decided, i.e., a mask which produces an optical beam of variable

polarization locally.
[Claim 11]A device used for forming an orientation pattern which induces with light an optical element indicated in any 1 paragraph of claims 1 thru/or 5 in a light-sensitive layer which induces polarization.
[Claim 12]A device which uses an optical element indicated in any 1 paragraph of claims 1 thru/or 5 as network structure of an optical waveguide or an optical waveguide.
[Claim 13]A device which uses an optical element indicated in any 1 paragraph of claims 1 thru/or 5 as a protection element of an identification card or a document.
[Claim 14]A device which uses an optical element indicated in any 1 paragraph of claims 1 thru/or 5 as an optical refraction element.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

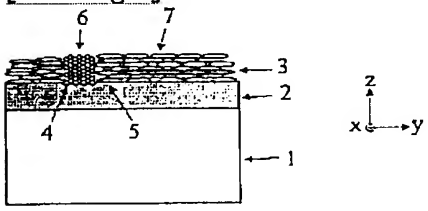
[Brief Description of the Drawings]
[Drawing 1]The outline sectional view of the example of the element of this invention.
[Drawing 2]The outline sectional view of other examples.
[Drawing 3]The outline plan of other examples.
[Drawing 4]A device which produces the element of this invention.
[Drawing 5]Various methods of guiding a needle.
[Description of Notations]
1 .. Substrate
2 .. Orientation layer
3 .. Liquid crystal layer
4 .. Field which carried out the scratch
5 .. Field which does not carry out a scratch
6 .. Field which carried out orientation to the x direction
7 .. Field which carried out orientation to the y direction

[Translation done.]

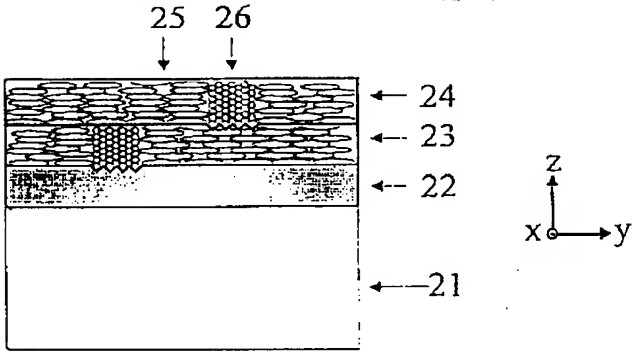
* NOTICES *

DRAWINGS

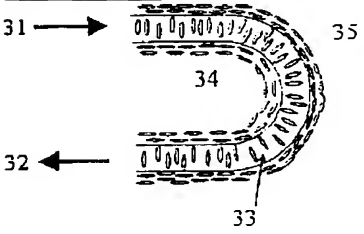
[Drawing 1]



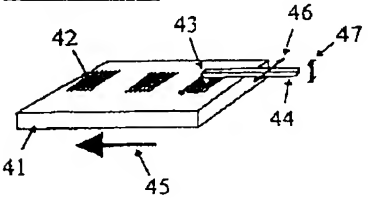
[Drawing 2]



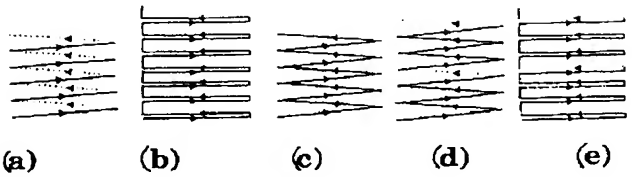
[Drawing 3]



[Drawing 4]



[Drawing 5]



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